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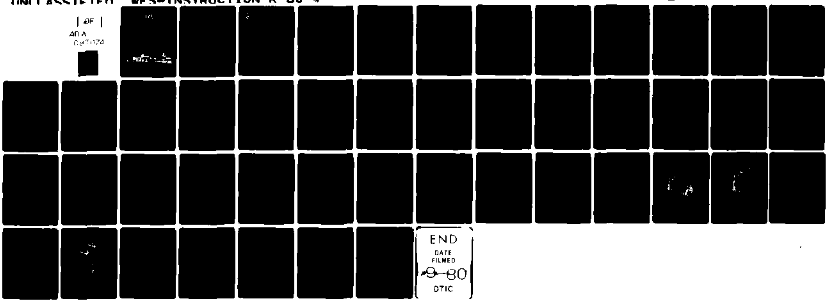


INSTRUCTION REPORT K-80-4

A THREE-DIMENSIONAL STABILITY ANALYSIS/DESIGN PROGRAM (3DSAD)

Report I

GENERAL GEOMETRY MODULE

by

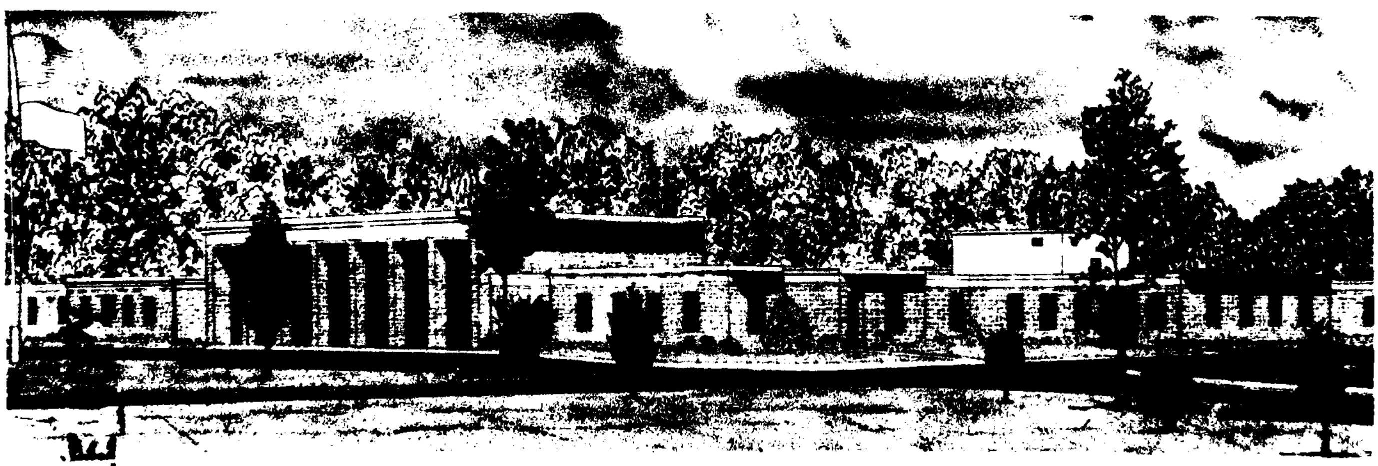
Fred T. Tracy

Automatic Data Processing Center
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

June 1980

Report I of a Series

A report under the Computer-Aided Structural Engineering (CASE) Project



Prepared for Office, Chief of Engineers, U. S. Army
Washington, D. C. 20314

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314

REPLY TO
ATTENTION OF:

DAEN-CWE-DS 1 July 1980

SUBJECT: Instruction Report K-80-4, A Three-Dimensional Stability Analysis/Design Program (3DSAD); Report 1: General Geometry Module

TO: All Corps Elements With Civil Works Responsibilities

1. The subject report is a user's guide for the General Geometry Module of a computer program called 3DSAD. 3DSAD can be used for stability analysis and design of general 3D structures. The program specifications for 3DSAD were developed by the Computer-Aided Structural Engineering (CASE) Task Group on 3D Stability. As is the goal with all CASE programs, the intent is to provide an organized, cost-effective means of making available to the structural engineer applicable computer programs ready for use when the design need arises.

2. Structural engineers will be readily able to discern from the description of this module of 3DSAD and from the examples given in the report the program's applicability to their needs. Detailed documentation of the program may be obtained from the Engineering Computer Program Library (ECPL) of the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss.

3. I strongly urge the use of this program by all Corps elements when applicable.

FOR THE CHIEF OF ENGINEERS

Lloyd A. Duscha

Incl
as

LLOYD A. DUSCHA
Chief, Engineering Division
Directorate of Civil Works

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Computer-aided design
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Structural analysis
Structural design

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This module of the three-dimensional stability analysis/design program (3DSAD) enables the engineer to describe the geometry of a three-dimensional structure, to interactively plot the desired structure, and then to obtain volume, weight, and centroid information for the structure. The general ways in which geometry is described are (a) two-dimensional cross sections extended in the third dimension, (b) eight-node brick elements, and (c) clusters of planar polygonal patches. Curved segments can be either circular,
(continued)

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20. ABSTRACT (Continued)

elliptical, or quadratic. Hidden lines in a view can be either deleted or dashed.

Preface

This report documents the General Geometry Module of the three-dimensional stability analysis/design (3DSAD) program. The module was developed and this report was written at the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss., in the Automatic Data Processing (ADP) Center by Mr. Fred T. Tracy. The work was sponsored through funds provided WES by the Civil Works Directorate, Office, Chief of Engineers, U. S. Army (OCE), under the Computer-Aided Structural Engineering (CASE) Project.

Specifications for the program were provided by the members of the CASE Task Group on 3D Stability. The members of the task group during the period of development were as follows:

Mr. Charles W. Kling, Mobile District (Chairman)
Mr. Robert Haavisto, Sacramento District
Mr. John Hoffmeister, Nashville District
Mr. Gerrett L. Johnson, Seattle District
Mr. Thomas J. Mudd, St. Louis District
Mr. William Holtham, New England Division

Mr. Donald R. Dressler, Structures Division, Civil Works Directorate, was the OCE point of contact. The work was done under the direction of Dr. N. Radhakrishnan, Special Technical Assistant, ADP Center. Mr. Dressler and Dr. Radhakrishnan also contributed in the definition of general concepts for the development of 3DSAD. Mr. D. L. Neumann was Chief of the ADP Center.

Directors of WES during the preparation and publication of this report were COL J. L. Cannon, CE, and COL N. P. Conover, CE. Technical Director was Mr. F. R. Brown.

Contents

A THREE-DIMENSIONAL STABILITY

ANALYSIS/DESIGN PROGRAM (3DSAD)

GENERAL GEOMETRY MODULE

Overview of the 3D Stability Program

1. The objective of the Computer-Aided Structural Engineering (CASE) Task Group on Three-Dimensional (3D) Stability Analysis is to develop computer programs that will help design engineers perform stability computations for general 3D structures. To enable this, a computer program called 3DSAD (three-dimensional stability analysis/design) is being developed in a modular fashion. Initially, 3DSAD will have three "general" modules:

a. General Geometry Module. This will:

(1) Define geometry based on two-dimensional (2D) cross sections extended in the third dimension, eight-node brick elements, or clusters of planar polygonal patches.

(2) Perform centroid, volume, and weight computations on described geometry.

(3) Employ interactive graphics extensively.

b. General Loads Module. This will compute loads on general 3D structures based on input of geometry, water levels, soil strata descriptions, etc.

c. General Analysis Module. This will perform overturning, bearing, and sliding computations.

The engineer performing an analysis of any 3D structure will be able to interact directly with the above modules.

2. Besides the general capabilities that are useful for any 3D structure, 3DSAD will also provide for simplified geometry and load input along with criteria check modules for some specific structures. This latter capability will permit interactive design of these structures. Examples of some specific structures for which modules will be developed are dams, locks, walls, powerhouses, and pumping stations.

3. A "specific" structure input module requires less data than

that for a general structure. Modules of this type will interact with the General Geometry Module and the General Loads Module to define the geometry and loads internally in the program. After analysis, a "specific" structure criteria check module will check pertinent values, change dimensions (if necessary), and cycle through the computations. A general schematic of the 3DSAD program is shown in Figure 1.

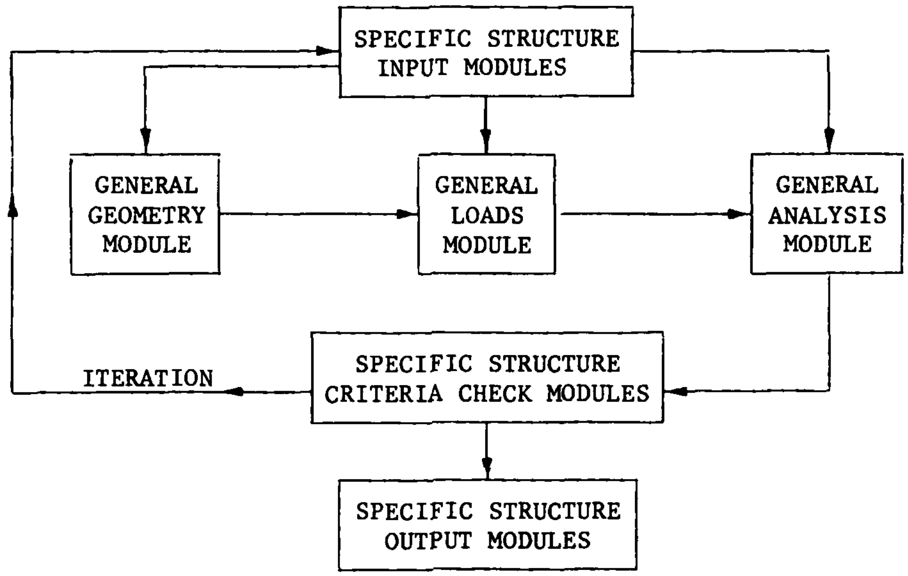


Figure 1. General schematic of 3DSAD

4. The 3DSAD program will be developed in phases. During the first phase, the three general modules will be developed. This approach will enable the stability analysis of any 3D structure although the input may be more complicated than need be for some specific structures. In the subsequent phases, the special input and criteria check modules will be developed for several specific structures.

The General Geometry Module

5. This report is a user's guide for the General Geometry Module. As stated above, this module enables the engineer to describe the geometry of a 3D structure, to interactively plot the described structure, and then to obtain volume, weight, and centroid information for the

structure. In the standalone mode of operation for a general structure, the user first creates a data file and stores it in a permanent disc file (20 characters maximum for the disc file description). He then uses the graphics to verify the data. When satisfied, the user types

VOLUME

to obtain the resultant volume, weight, and centroid of the structure.

Coordinate System

6. The coordinate system used is shown in Figure 2. Note that

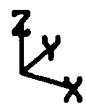


Figure 2. Coordinate system

X is to the right, Z is up, and Y is into the paper. This is a right-handed system.

Data Types

7. Data are either points, curves, surfaces, or solids. Three types of solid pieces can be used to describe the geometry. They are:

a. Blocks.

b. Eight-node brick elements.

c. Clusters of surface patches to form a solid.

Blocks

8. A block consists of a 2D cross section defined in either the X-Y, the X-Z, or the Y-Z plane which grows in the Z, Y, or X direction, respectively, to form a solid piece of geometry. Figure 3 shows a typical cross section defined in the X-Z plane, and Figure 4 shows the generated block. The X-Z plane is the default plane.

9. Figure 5 shows a data file and two cylindrical blocks: one generated from an X-Z cross section and the other from an X-Y cross

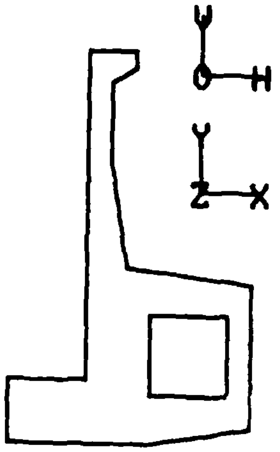


Figure 3. Two-dimensional cross section

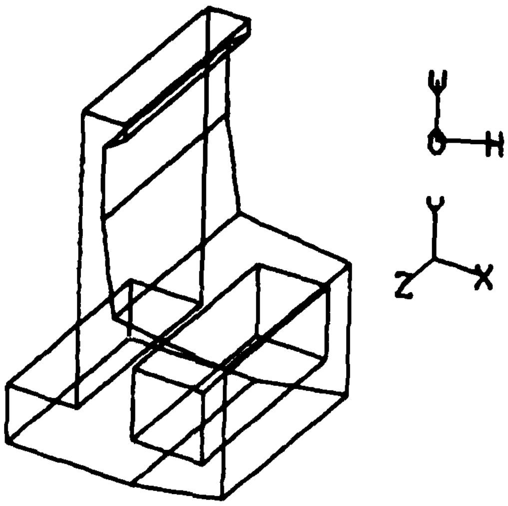


Figure 4. Generated block

```
10 XZ
20 POIN 4
30 1 -5 0 0
40 2 0 0 -5
50 3 5 0 0
60 4 0 0 5
70 CIRC 1 2 5
80 CIRC 2 3 5
90 CIRC 3 4 5
100 CIRC 4 1 5
110 BLOC BL1 100. 40.
120 1. 1.
130 4 1 2 3 4
140 XY
150 POIN 4
160 5 -5 20 5
170 6 0 15 5
180 7 5 20 5
190 8 0 25 5
200 CIRC 5 6 5
210 CIRC 6 7 5
220 CIRC 7 8 5
230 CIRC 8 5 5
240 BLOC BL2 100. 40.
250 1. 1.
260 4 5 6 7 8
```

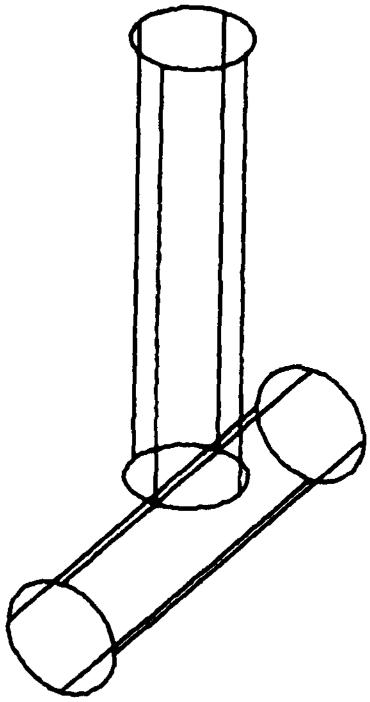


Figure 5. Two cylinders

section. Note that in the data file "XZ" indicates that the data refer to the X-Z plane and that "XY" is used when the switch is made to referring to the X-Y plane. Also, points are first defined, then any curves, and finally the block itself.

10. The line segments describing the cross section can be either straight, circular, quadratic, or elliptical. Further, the section can grow smaller or larger as it is extended in the perpendicular direction. Any number of holes (for culverts, etc.) can be defined in the cross section as well.

Bricks

11. The eight-node brick element is another useful way to describe geometry. Figure 6 shows a typical brick element.

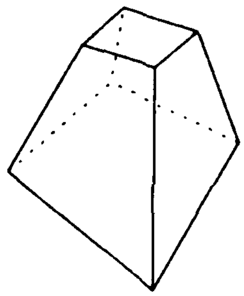


Figure 6. Brick element

Surface patches

12. Sometimes it is desirable to describe a solid piece of geometry by a group of surface patches. This program allows for planar polygonal patches (Figure 7). The tetrahedron is described by four triangular patches (faces).

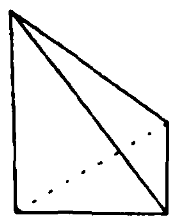


Figure 7. Planar patches

Building Data Files

WES and Macon computer systems

13. To build a new data file, first type

NEW

Then type the file with line numbers until finished. The * will appear after each line is typed. Then type

SAVE NAME

where NAME is a 1- to 20-character file description, upon completion. If a line is wrong, simply retype it. Type

RESAVE NAME

after making all corrections.

14. Input data files for this program are read with a free-field format. Thus, data are separated by either blanks or commas, and floating-point data that are whole numbers do not need a trailing decimal point. The following is a sample data file building sequence in the style of the U. S. Army Engineer Waterways Experiment Station (WES) and the Office of Personnel Management, Macon, Ga. (Macon), computer systems:

```
NEW
*10 1 10. 0.
*20 2 10. 10.
*30 3 0. 10.
*40 0. 0.
*SAVE DAM1
DATA SAVED-DAM1
*5 POINTS 4
*RESA DAM1
DATA SAVED-DAM1
*LIST

5 POINTS 4
10 1 10. 0.
20 2 10. 10.
30 3 0. 10.
40 0. 0.
```

Boeing computer system

15. To build a new data file, first type

NEW,NAME

where NAME is a one- to seven-character name starting with a letter. Then type the file with line numbers until finished. The C> prompt will not reappear after the first line is typed. Then type

SAVE,NAME

upon completion. If a line is wrong, simply retype it. Type

REPLACE,NAME

after making all corrections.

16. Input data files for this program are read with a free-field format. Thus, data are separated by either blanks or commas, and floating-point data that are whole numbers do not need a trailing decimal point. A Boeing computer system sample data file building sequence appears as:

```
C>NEW,LOCK1
C>10 POINTS 4
20 1 0 0
30 2 100.5 0
40 3 100.5 20
50
SAVE,LOCK1
C>LIST
10 POINTS 4
20 1 0 0
30 2 100.5 0
40 3 100.5 20
C>50 4 0 20
REPLACE,LOCK1
C>LIST
10 POINTS 4
20 1 0 0
30 2 100.5 0
40 3 100.5 20
50 4 0 20
C>
```

Running the Program

17. To run 3DSAD on the WES and Macon systems, type

RUN WESLIB/CORPS/X8100,R

To run the program on the Boeing system, first type

OLD,CORPS/UN=CECELB

Then type

CALL,CORPS,X8100

each time the program is to be executed. The computer first responds with

```
A THREE-DIMENSIONAL STABILITY ANALYSIS/DESIGN PROGRAM
                         (3DSAD)
                      A PRODUCT OF
          Computer Aided Structural Engineering
                         (CASE)
               PROGRAM NO. 713-F3-R0-008
    Computer Aided Design (CAD) OF STRUCTURAL STABILITY
                   <> <> <> <> <> <>
ENTER  ?, HELP, OR WHAT TO GET VALID RESPONSES.
ENTER STOP, END, QUIT, OR DONE TO TERMINATE PROGRAM.
STRUCTURE TYPE OR GENERAL MODULE ?
```

The user then gives

GEOM

for the General Geometry Module.

18. The next question the program asks is

RESTART FILE NAME OR CR?

where "CR" stands for carriage return. The restart file saves all data that the user has thus far input which pertain to building a structure. These include any data input from another data file. The user gives a carriage return if he does not want a restart file.

19. The next question is

OUTPUT FILE NAME OR CR?

In this file is placed the resulting weight and centroid of the structure in the form of a point load; for example,

2 PTLD WT   17.584   20.000   11.004   0.   0.   -8067.939

The file consists of one line with line number 2, X centroid of 17.584, Y centroid of 20.000, Z centroid of 11.004, and weight of 8067.939. A carriage return is given if an output file is not wanted. The file is written when the END command is given.

20. The third question is

COMMAND?

The commands will be discussed in detail in the next section.

Commands

21. The program uses commands (PLOT, ROTATE, etc.) to both build and plot the data. The commands are:

a. Data building:

XY XZ YZ POINT
CIRCLE ELLIPSE
QUADRATIC
BLOCK BRICK FACE
TRANSLATE

b. Utility:

INPUT VOLUME
END GO RETURN
CLEAR

c. Plotting:

PLOT WINDOW ZOOM
ROTATE ISOMETRIC
LABEL NOLABEL
DASH HIDE SOLID
INITIALIZE

This list is obtained by typing "?" at the command level. Only the minimum number of letters of a command need to be given. The user can, however, type the entire word if he prefers. Commands and their accompanying data can be put into a data file or typed interactively while running the program. The basic command sequence is:

INPUT FILNAM	Read data from file FILNAM
PLOT	Plot data
VOLUME	Compute and print volume
END	End

22. Each command will now be described in detail. In giving the format for the commands, actual letters to be typed will be enclosed in quotes to distinguish them from variable names. The quotes do not have to be typed when the user issues the command. The required letters are shown in all capitals; the optional letters are shown in lower letters.

<u>XY</u>

23. The format for this command is

"XY"

This command turns on the flag that states that all CIRCLE and ELLIPSE commands define circular and elliptical arcs in the X-Y plane, and all BLOCK commands start with cross sections in the X-Y plane and grow in the Z direction (see Figure 5 and the associated data file). This condition is held until an XZ or YZ command is encountered.

<u>XZ</u>

24. The format for this command is

"XZ"

This command is like XY except that now circular and elliptical arcs are defined in the X-Z plane, and blocks start with cross sections in the X-Z plane and grow in the Y direction. XZ is assumed until an XY or YZ command is encountered. XZ is the default condition.

<u>YZ</u>

25. The format for this command is

"YZ"

This command is like XY and XZ except that now circular and elliptical arcs are defined in the Y-Z plane, and blocks start with cross sections in the Y-Z plane and grow in the X direction. YZ remains in effect until an XY or XZ command is encountered.

POINTS

26. The user first defines some points using the POINTS command. Its format is

"POints" NPT

where NPT is the number of points. After this line, an identification number and (X, Y, Z) coordinates for each point are given.

27. Interactive mode. Below is an example of the POINTS command when made interactively on the Boeing system:

```
 COMMAND ?
I>POIN 4
 N, X, Y, Z
I>1 0 0 565
I>2 44 0 565
I>3 44 0 577
I>4 40 0 577
I>5 40 0 597
I>6 22 0 617
I>7 22 0 633
I>8 4 0 633
I>9 4 0 577
I>10 0 0 577
I>11 9 0 585
I>12 9 0 595
I>13 19 0 595
I>14 19 0 585
 DONE
I>
```

28. Data file mode. The same data are put in a file as shown below:

```
10 POINTS 14
20 1 0 0 565
30 2 44 0 565
40 3 44 0 577
50 4 40 0 577
60 5 40 0 597
70 6 22 0 617
80 7 22 0 633
90 8 4 0 633
100 9 4 0 633
110 10 0 0 577
120 11 9 0 585
130 12 9 0 595
140 13 19 0 595
150 14 19 0 585
```

CIRCLE

29. After the user has defined some points to work with, he must then define any curved line segments. That is, line segments between points are assumed straight unless otherwise specified. The possible ways of using the CIRCLE command are

```
"Circle" N1 N2 R
"Circle" N1 N2 R "Left"
"Circle" N1 N2 R "Right"
```

N1 and N2 are two point numbers between which a circular arc of radius R is drawn. "LEFT" or "RIGHT" designates to which side of the line segment N1 to N2 the center of the circle is. The following data file results in the plot shown in Figure 8:

```
10 POIN 4
20 1 0 0 -5
30 2 5 0 0
40 3 0 0 5
50 4 -5 0 0
60 CIRC 1 2 5
70 CIRC 2 3 5 LEFT
80 CIRC 4 3 5 RIGHT
90 CIRC 4 1 5
```

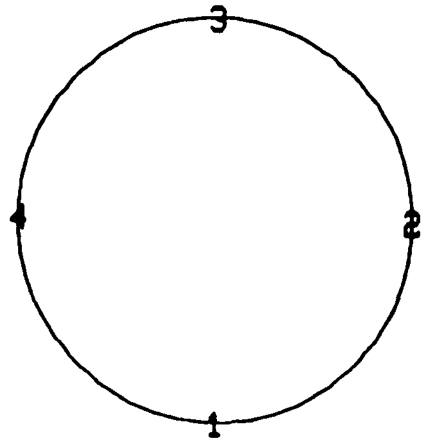


Figure 8. CIRCLE command

30. The circle will be defined in either the X-Y, X-Z, or Y-Z plane, depending on whether the XY, XZ, or YZ command has been given before the circle is defined. XZ is the default option.

ELLIPSE

31. The user can also define an elliptical line segment. The possible ways of using the ELLIPSE command are

```
"ELlipse" N1 N2 A B
"ELlipse" N1 N2 A B "Left"
"ELlipse" N1 N2 A B "Right"
```

N1 and N2 are two point numbers between which an elliptical arc having semimajor axis length A and semiminor axis length B is drawn. "LEFT" and "RIGHT" have the same meaning as in the CIRCLE command. The following data file results in the plot shown in Figure 9:

```
10 POIN 4
20 1 0 0 -5
30 2 10 0 0 0
40 3 0 0 5
50 4 -10 0 0
60 ELLI 1 2 10 5
70 ELLI 2 3 10 5 LEFT
80 ELLI 4 3 10 5 RIGHT
90 ELLI 4 1 10 5
```

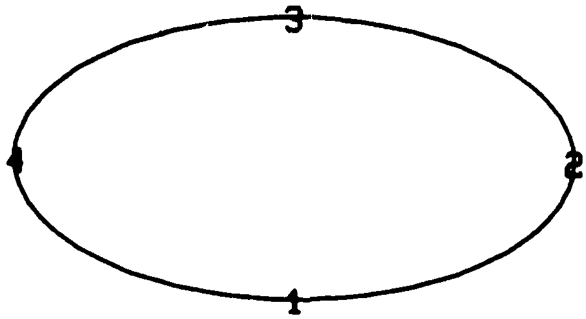


Figure 9. ELLIPSE command

Note that the semimajor and semiminor axes are always parallel to the coordinate axes.

32. As with the CIRCLE command, the ellipse will be defined in one of the principal planes, depending on whether XY, XZ, or YZ has been previously given.

<u>QUADRATIC</u>

33. The user may need a curved line segment which is not circular or elliptical. The quadratic line segment is provided for this purpose. The command format is

"Quadratic" N1, N2, XQQ, YQQ, ZQQ

N1 and N2 are the point numbers that the quadratic line segment goes between, and (XQQ, YQQ, ZQQ) is an interpolation point (Figure 10) that

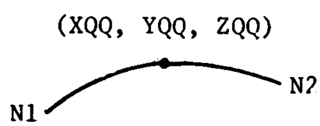


Figure 10. Quadratic plotting

the curve must go through. The following data file results in the plot shown in Figure 11:

```
10 POIN 4
20 1 0 0 -5
30 2 5 0 0
40 3 0 0 5
50 4 -5 0 0
60 QUAD 1 2 4 0 -3
70 QUAD 2 3 3 0 4
80 QUAD 3 4 -4 0 3
90 QUAD 4 1 -3 0 -4
```

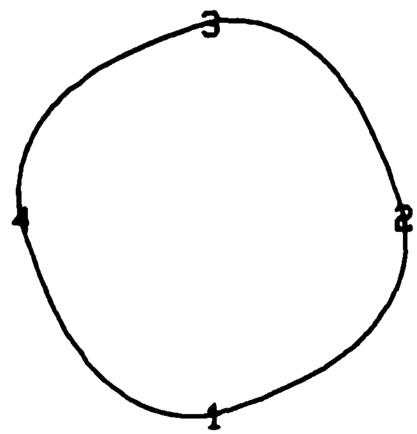


Figure 11. QUADRATIC command

BLOCK

34. Perhaps the most useful way provided in this program to define solids is the BLOCK command. A two-dimensional cross section defined in one of the three principal planes (X-Y, X-Z, or Y-Z) is allowed to grow in the third (perpendicular) direction. The format for this command is

"BLock" NAME DENS DEPTH NHOLE

where NAME is a four-character name of the block, DENS is the density, DEPTH is how far the cross section is extended, and NHOLE is the number of holes in the cross section. After the BLOCK command is given in the interactive mode, the following questions are asked for the outer boundary and each hole:

SFX, SFZ, XAPEX, ZAPEX, HFX, HFZ ?

CONNECTIVITY DATA ?

If XY has been typed previously, SFZ is replaced by SFY, HFZ by HFY, and ZAPEX by YAPEX. In like manner, YZ typed previously results in SFX being replaced by SFY, HFX by HFY, and XAPEX by YYAPEX. Although the following discussion uses the default X-Z plane, the principles are the same for XY and YZ.

35. To understand these questions and the BLOCK command, first consider the following example. The 14 points in Figure 12 have just

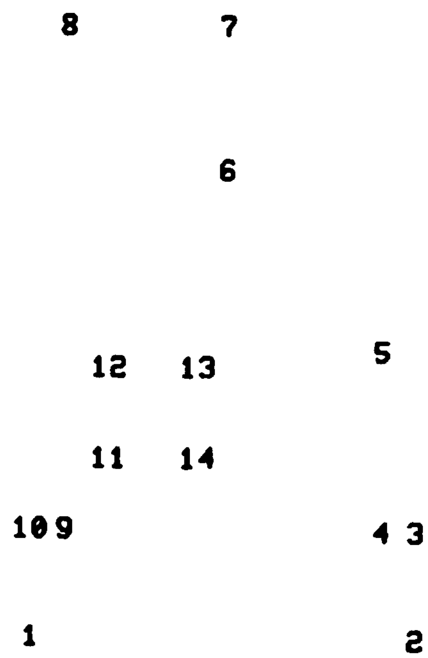


Figure 12. 14 points

been read in by the POINTS command. Then the question and answer sequence

```
 COMMAND ?
I>BLOCK BL1 100. 50. 1
 OUTER BOUNDARY DATA
 SFX, SFZ, XAPEX, ZAPEX, HFX, HFZ ?
I>1 1
 CONNECTIVITY DATA ?
I>10 1 2 3 4 5 6 7 8 9 10
 DATA FOR HOLE 1
 SFX, SFZ, XAPEX, ZAPEX, HFX, HFZ ?
I>1 1
 CONNECTIVITY DATA ?
I>4 11 12 13 14
 DONE
I>
```

is typed. Figure 13 shows the generated block. If these data were placed into a data file, it would appear as

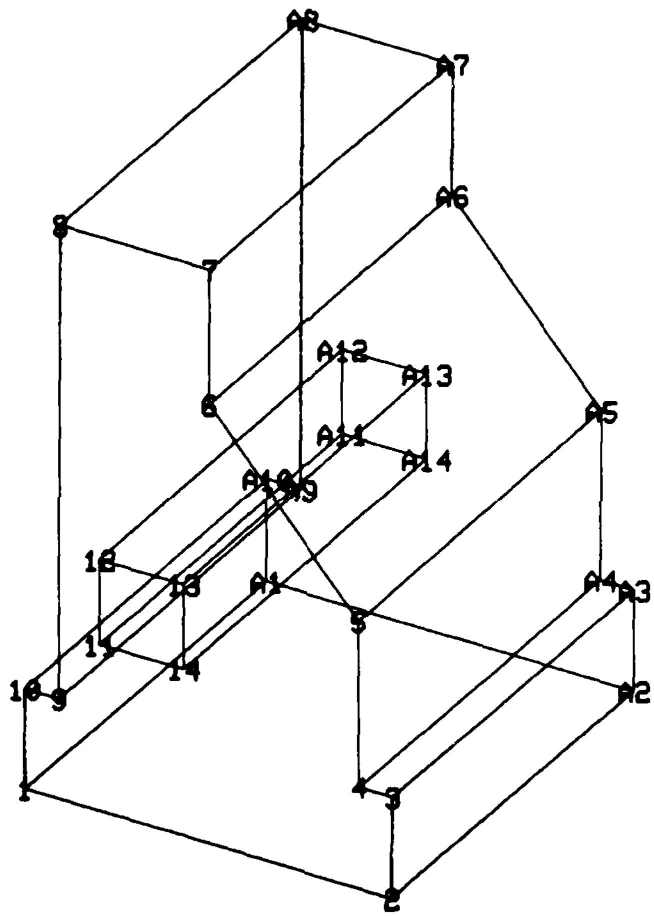


Figure 13. Generated block

```
160 BLOCK BL1 100. 5. 1
170 1 1
180 10 1 2 3 4 5 6 7 8 9 10
190 1 1
200 4 11 12 13 14
```

Note that the number of points, followed by the point numbers given in counterclockwise order, form the connectivity data of the outer boundary. The connectivity data for each hole are the same except that the point numbers are given in clockwise order.

36. Each original point of the cross section (numbered 1, 2, 3, etc.) will have a corresponding point generated a distance DEPTH in the Y direction (A1, A2, A3, etc.). The new (X, Y, Z) coordinates of these points are computed by

YNEW = YOLD + DEPTH

XNEW = (XOLD - XAPEX) * SFX + XAPEX

ZNEW = (ZOLD - ZAPEX) * SFZ + ZAPEX

Note that if SFX and SFZ are equal to one

XNEW = XOLD

ZNEW = ZOLD

independent of the apex (XAPEX, ZAPEX). This allows XAPEX and ZAPEX in the data for Figure 13 to default to zero.

37. Figures 14-17 show some data files and their corresponding plots, which illustrate the impact of SFX, SFZ, XAPEX, and ZAPEX. So

```
10 POIN 4
20 1 0 0 0
30 2 10 0 0
40 3 10 0 10
50 4 0 0 10
60 BLOCK BL1 100. 15.
70 1 1
80 4 1 2 3 4
```

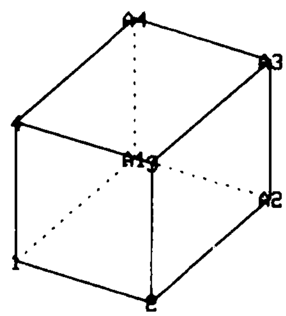


Figure 14. No scaling

```
10 POIN 4
20 1 0 0 0
30 2 10 0 0
40 3 10 0 10
50 4 0 0 10
60 BLOCK BL1 100. 15.
70 1 .5
80 4 1 2 3 4
```

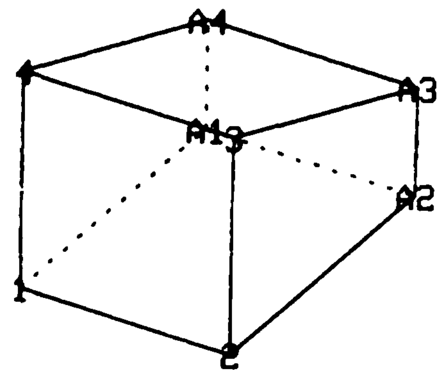


Figure 15. Scaling in Z only

```
10 POIN 4
20 1 0 0 0
30 2 10 0 0
40 3 10 0 10
50 4 0 0 10
60 BLOCK BL1 100. 15.
70 .5 .5 5. 5.
80 4 1 2 3 4
```

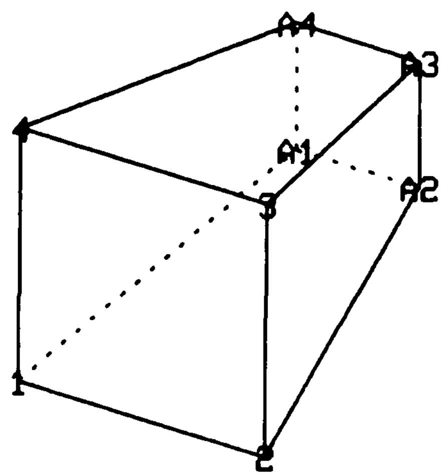


Figure 16. Scaling in X and Z with nonzero apex

```
10 POIN 4
20 1 0 0 -5
30 2 5 0 0
40 3 0 0 5
41 CIRC 1 2 5.
42 CIRC 2 3 5.
43 CIRC 3 4 5.
44 CIRC 4 1 5.
50 4 -5 0 0
60 BLOCK BL1 100. 15.
70 .5 .5 0. 0.
80 4 1 2 3 4
```

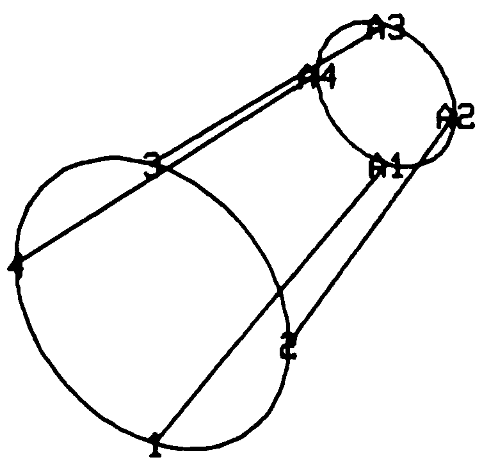


Figure 17. Same as Figure 16, except with circular line segments

SFX and SFZ are scale factors which scale the "front" X and Z coordinates to determine the X and Z coordinates for the "back" face. In like manner HFX and HFZ determine the X and Z coordinates for points halfway between the front and back faces.

38. In all the previous examples, HFX and HFZ were zero. This generated straight lines connecting the front cross section with the back cross section. To obtain a quadratic variation (shown by the data file and plot in Figure 18) interpolation points are computed to a distance

```
10 POIN 4
20 1 0 0 0
30 2 10 0 0
40 3 10 0 10
50 4 0 0 10
60 BLOCK BL1 100. 15.
70 .3 .3 5. 5. .8 .8
80 4 1 2 3 4
```

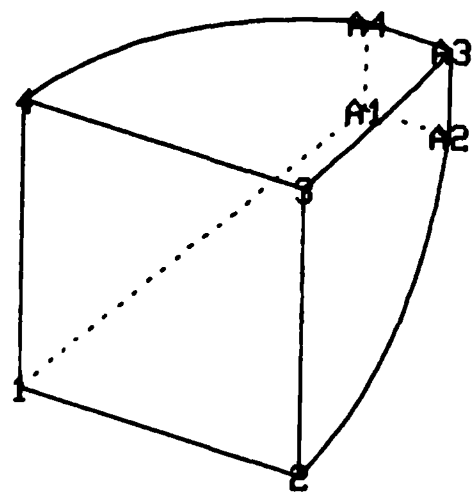


Figure 18. Quadratic variation

DEPTH/2 from the front face for all the connecting line segments. The (X, Y, Z) coordinates of each interpolation point are computed by

YINT = YOLD + DEPTH * .5

XINT = (XOLD - XAPEX) * HFX + XAPEX

ZINT = (ZOLD - ZAPEX) * HFZ + ZAPEX

<u>BRICK</u>

39. Another way to describe geometry is by the use of the eight-node brick element. Its format is

"BRick" NAME DENS

where name is a four-character name and DENS is the density. Following the command, the user gives the eight nodes which define the element connectivity. Care must be taken to number the nodes of the element to insure that they produce a positive volume. Figure 19 and the data file with it illustrate a typical example.

```
210 POIN 8
220 29 0 0 10
230 30 10 0 10
240 31 10 10 10
250 32 0 10 10
260 33 0 0 20
270 34 10 0 20
280 35 10 10 20
290 36 0 10 20
300 BRICK B1 100.
310 29 30 31 32 33 34 35 36
```

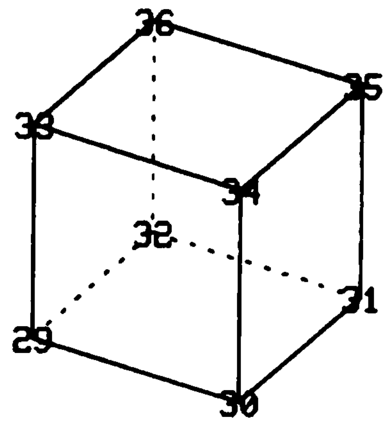


Figure 19. BRICK command

FACE

40. The FACE command is used to define a solid object by giving its individual faces. Faces are constrained to being planar polygons. The format of the command is

"Face" NAME DENS NFACE

where NAME is a four-character name, DENS is the density of the cluster of faces being defined, and NFACE is the number of faces. After the command is given, the connectivity data for each face must be given. The connectivity data for each face consist of the number of points of the polygon followed by the point numbers. The order of the points must be counterclockwise if the outward normal to the face points out of the picture (-Y direction) and must be clockwise if the outward normal points into the picture (+Y direction). Figure 20 and the accompanying data file show a typical example.

TRANSLATE

41. Objects that have been defined can be moved or translated in space from one position to another by using the TRANSLATE command. The possible options of this command are

```
320 POIN 4
330 37 100 -50 0
340 38 110 -50 0
350 39 105 -40 0
360 40 100 -45 10
370 FACE F1 150. 4
380 3 38 39 40
390 3 37 39 38
400 3 37 38 40
410 3 37 40 39
```

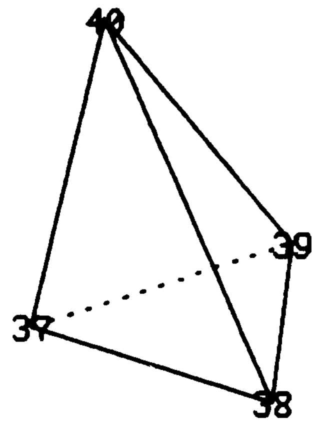
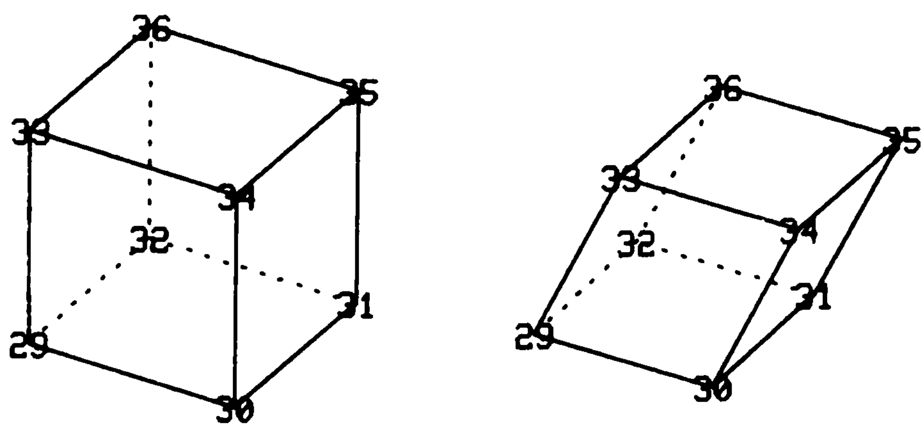


Figure 20. FACE command

"Translate"
"Translate" "POINts"
"Translate" "POINts" N1 N2
"Translate" "LINEs"
"Translate" "LINEs" N1 N2
"Translate" "DENSity" DENS
"Translate" NAME

Note that points, lines, items with the same density, and items with the same name can be translated. Figure 21 shows an example of moving points



a. Before b. After

Figure 21. TRANSLATE command

by typing the following question and answer sequence:

```
 COMMAND ?
I>TRAN POIN 29 32
 INPUT DX, DY DZ.
I>-5 0 0
 DONE
I>
```

Here DX, DY, and DZ are the increments by which the data are to be translated.

INPUT

42. This command allows the user to input or read into memory a permanent data file saved on disc. Its format is

"INPut" FLNM1
"INPut" FLNM1 "P"

where FLNM1 is a 1- to 20-character file description. If the P is also typed, a detailed printout of the input file is printed on the terminal as if it had been done interactively.

VOLUME

43. This command allows the user to obtain volume information whenever it is typed. Its format is

"Volume"
"Volume" "ALL"
"Volume" NAME

If just VOLUME is typed, only the totals for the entire structure are given. If NAME is provided, only the volume data for data having that name are given. VOLUME ALL will yield a detailed listing of the data by name; for example,

NO.	NAME	VOLUME	WEIGHT	XCG	YCG	ZCG
1	BL1	3141.59	314159.27	0.	20.00	0.
2	BL2	3141.59	314159.27	0.	20.00	25.00
	TOTAL	6383.19	628318.53	0.	20.00	12.50

END

44. This command is given to terminate running of the program. Its format is

"ENd"

GO

45. This command is used when the program is being used for a specific structure such as a dam or lock. Giving the GO command automatically causes the program to go on to the General Loads Module. The format for this command is

"GO"

RETURN

46. This command is used to return to the question

STRUCTURE TYPE OR GENERAL MODULE?

so that the user can select another module. Typically the next module to go to is the General Loads Module. The format for this command is

"REturn"

CLEAR

47. This command is used to clear all definition of geometry from memory so as to begin a new problem. Its format is

"CLear"

PLOT

48. This command allows part or all of the data base to be plotted. Its format is

```
"PLot"
"PLot" "POINts"
"PLot" "POINts" N1 N2
"PLot" "LINEs"
"PLot" "LINEs" N1 N2
"PLot" "DENSity" DENS
"PLot" NAME
```

By just typing PLOT, all the lines will be plotted. Thus, the default code is LINES. By giving N1 and N2, a portion of the total number of lines can be plotted. Points only can be plotted by typing PLOT POINTS. If N1 and N2 are given, only those points between N1 and N2 are plotted. Also, everything with a given density (DENS) can be plotted. All data with a name (NAME) can be plotted as well.

WINDOW

49. This command allows the user to pick a window, or portion of the plot on the screen, and plot just that portion. Its format is

"Window"

After typing WINDOW, the cross hairs will appear. Place them on the lower left-hand corner of the desired window, and type any character and a carriage return. The cross hairs will reappear and the process will be repeated, except that this time place the cross hairs on the upper right-hand corner of the window. Figure 22 shows a full picture of a brick element, while Figure 23 shows a window of that plot.

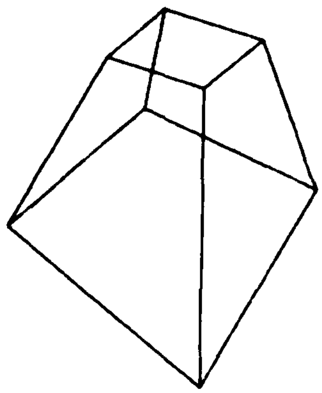


Figure 22. Full picture of brick element

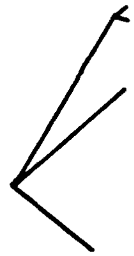


Figure 23. Window of Figure 23 brick element

ZOOM

50. This command allows the user to decrease or increase the size of the current picture on the screen. The format for this command is

"Zoom" FMAG

where FMAG is a scale factor which dictates whether the current picture is made bigger or smaller. If FMAG is less than one, the picture is decreased in size; if FMAG is greater than one, the picture is increased in size.

ROTATE

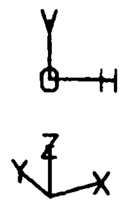
51. This command allows the user to rotate the structure for viewing at different angles. Its format is

"Rotate" "H" ANGLE
"Rotate" "V" ANGLE
"Rotate" "O" ANGLE

where H means horizontal axis, V means vertical axis, and O means outward axis. ANGLE is a counterclockwise, positive angle in degrees that determines how much the structure is to be rotated about the given axis. Note, as shown in the following example, the distinction between the coordinate system of the (X, Y, Z) data and that of the rotation axes. A good set of rotations is

ROTATE V 30.

ROTATE H 30.



ISOMETRIC

52. This command allows the user to specify a standard set of notations rather than hunt for the desired plot. Its format is

"ISometric"

It is equivalent to the two rotations given above.

LABEL

53. This command allows labels to be plotted along with the line segments. The format for this command is

"Label" "POINts"
"Label" "LINEs"
"Label" "BLOCks"
"Label" "BRICks"
"Label" "FACEs"

Currently, only points can be labeled. Figure 24 shows the result of typing

LABEL POINTS

PLOT

for the plot in Figure 22.

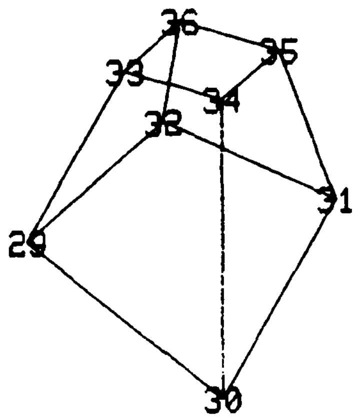


Figure 24. LABEL command

NOLABEL

54. This command turns off the labels. Its format is

"Nolabel" "POINts"
"Nolabel" "LINEs"
"Nolabel" "BLOCks"
"Nolabel" "BRICks"
"Nolabel" "FACEs"

NOLABEL is default over LABEL.

DASH

55. This command allows the user to dash the lines that are hidden from view. The format for this command is

"Dash"

Figure 25 shows the results of dashing the plot in Figure 22.

HIDE

56. This command allows the user to delete hidden lines from the plot. Its format is

"Hide"

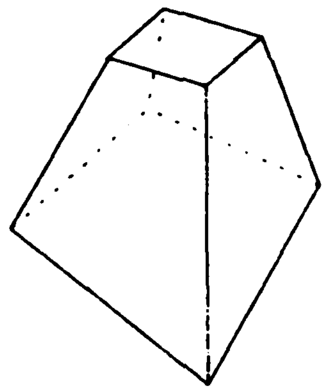


Figure 25. DASH command

Figure 26 shows the result of using the HIDE command on the plot in Figure 22.

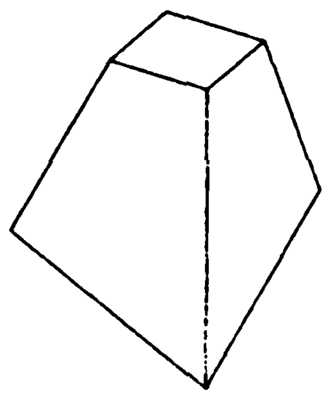


Figure 26. HIDE command

SOLID

57. This command causes all the lines to be solid (as compared to dashed or deleted). The format for this command is

"Solid"

SOLID is default over DASH and HIDE.

INITIALIZE

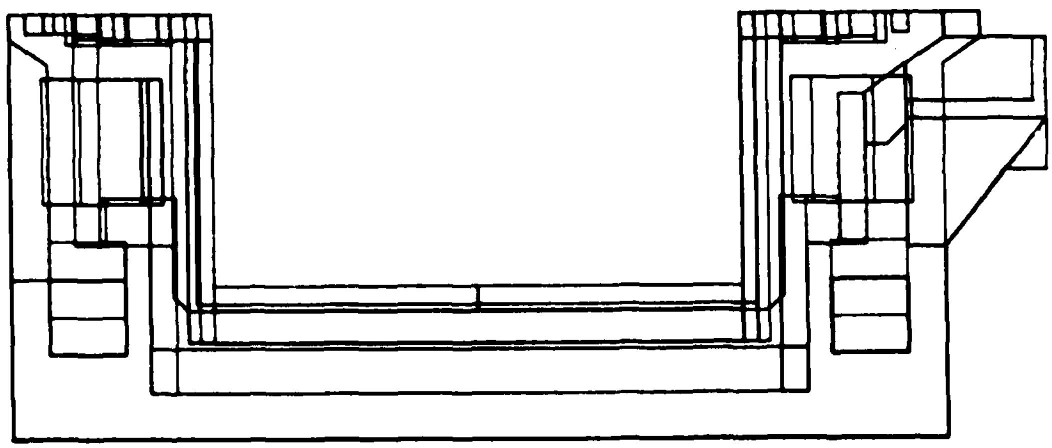
58. This command initializes plot data back to the original values. Its format is

"INItialize"

Currently, the angles of rotation are reset to zero.

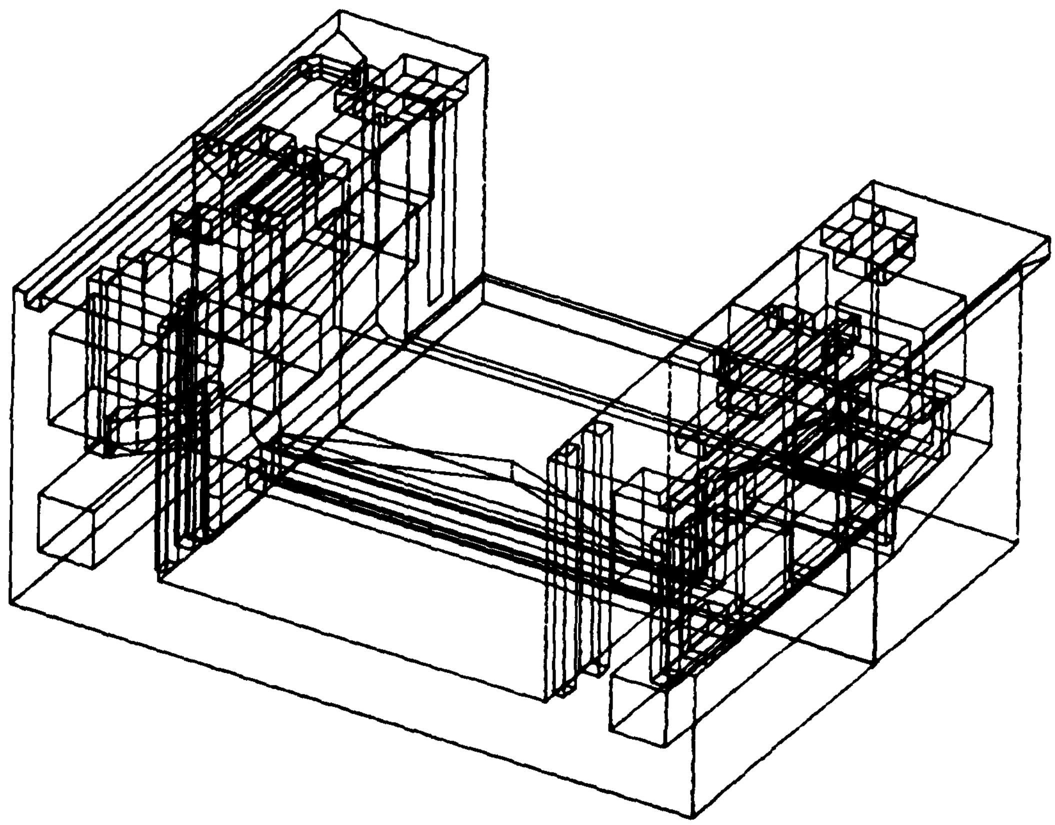
Practical Applications

59. Plates 1 and 2 are plots (provided by Messrs. Thomas J. Mudd and John Jobst, St. Louis District) that illustrate practical applications of this program. (See also the write-up prepared for the St. Louis District by Obbie Thompson, Jr., Structural Division, entitled, "Stability Analyses Program Documentation.")



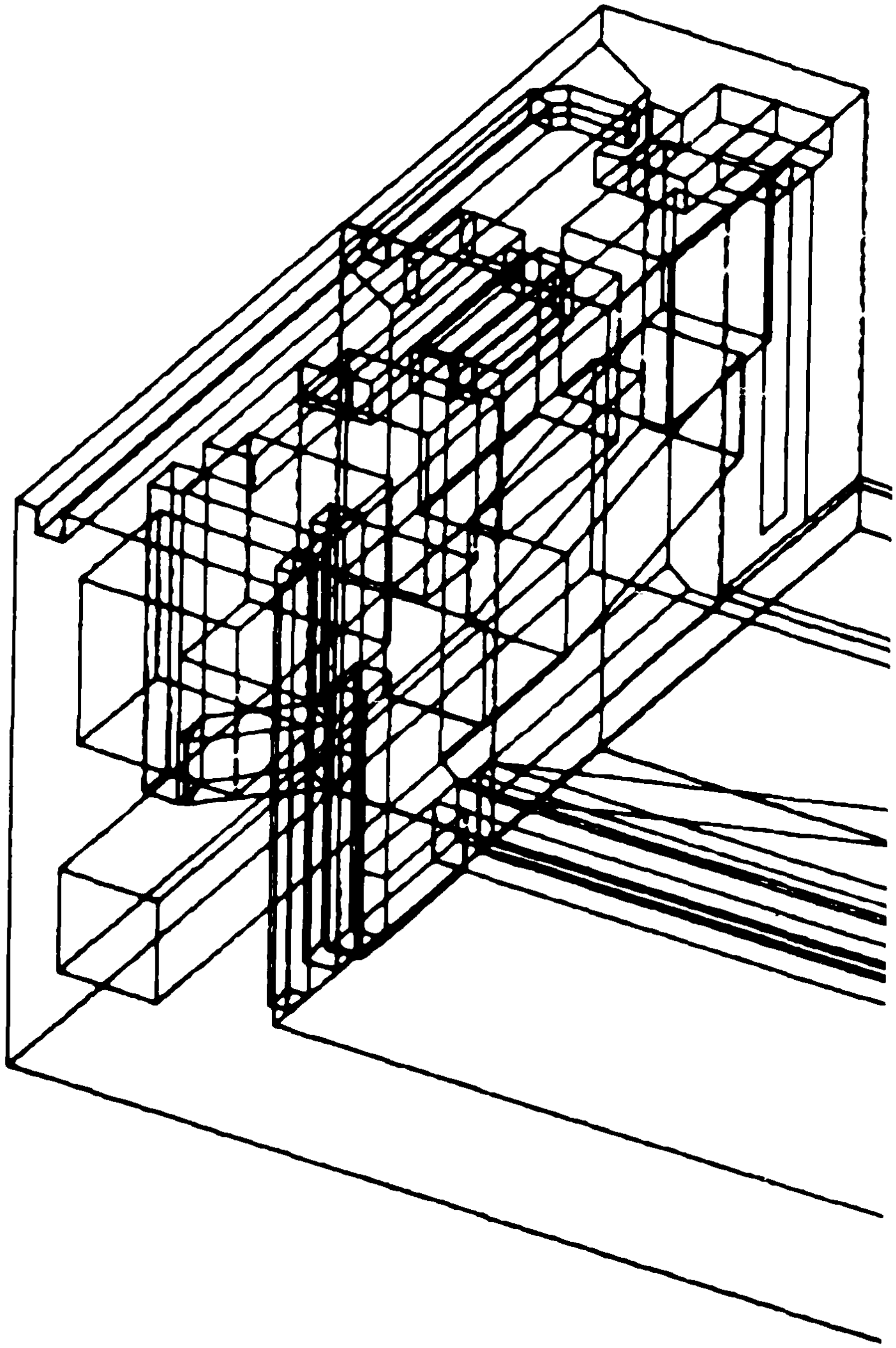
STRUCTURE 1
Front View

PLATE 1A



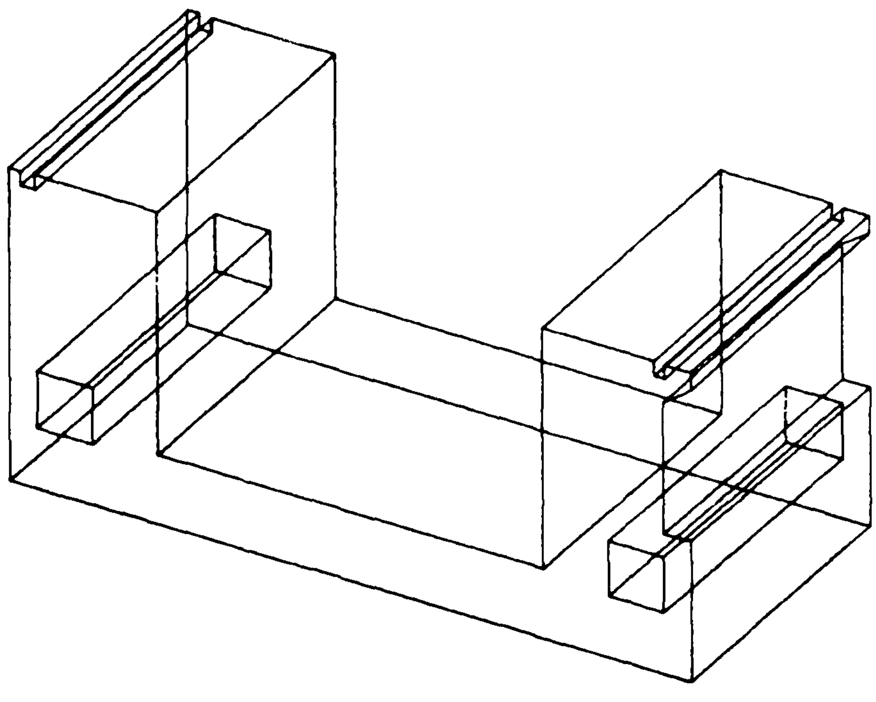
STRUCTURE 1
Overhead View

PLATE 1B



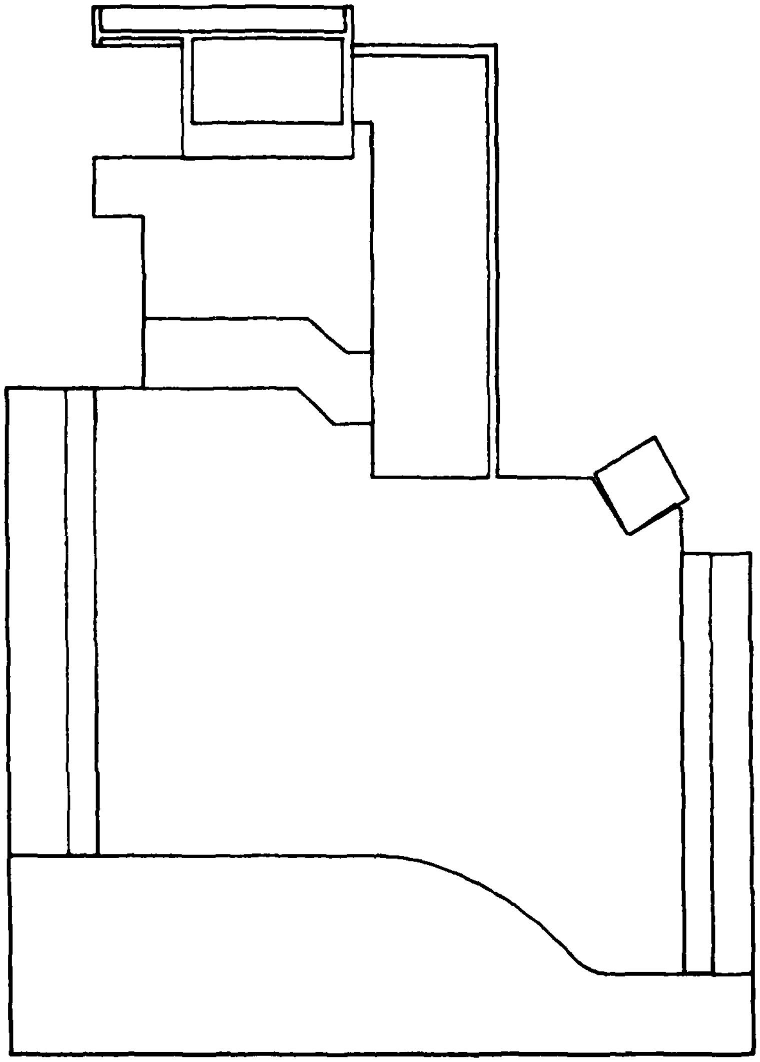
STRUCTURE 1
Window of
Overhead View

PLATE 1C



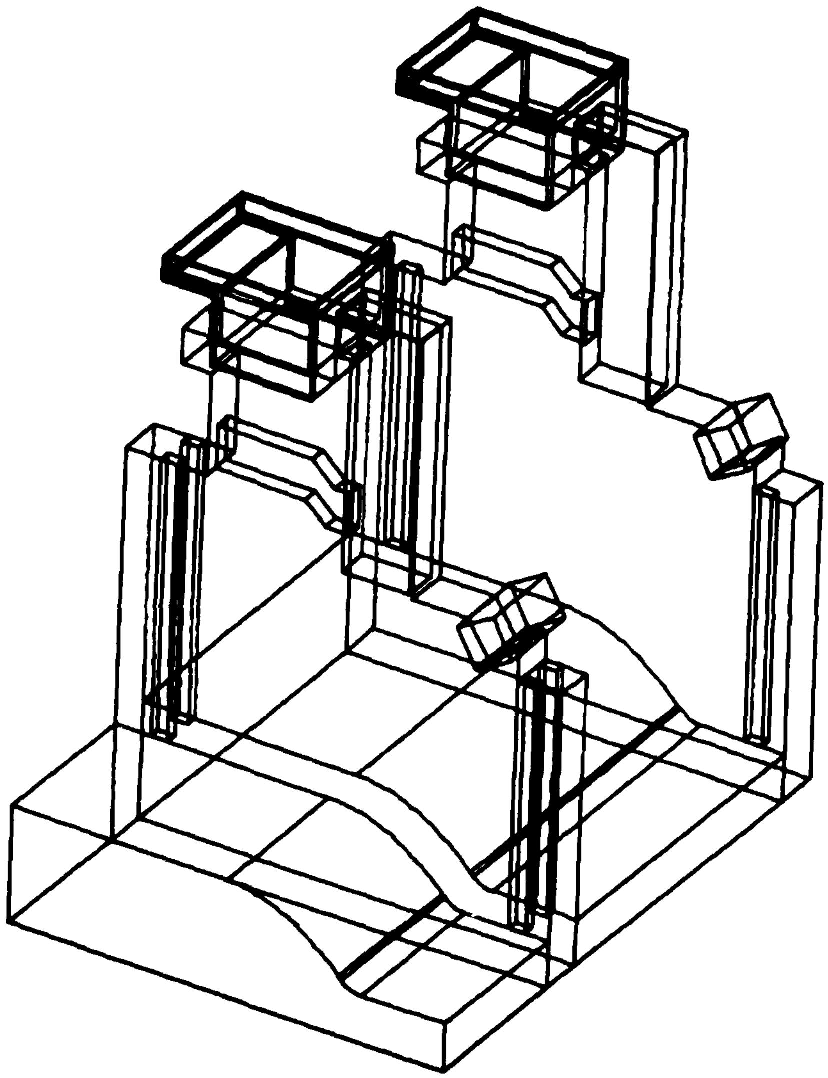
STRUCTURE 1
First Block

PLATE 1D



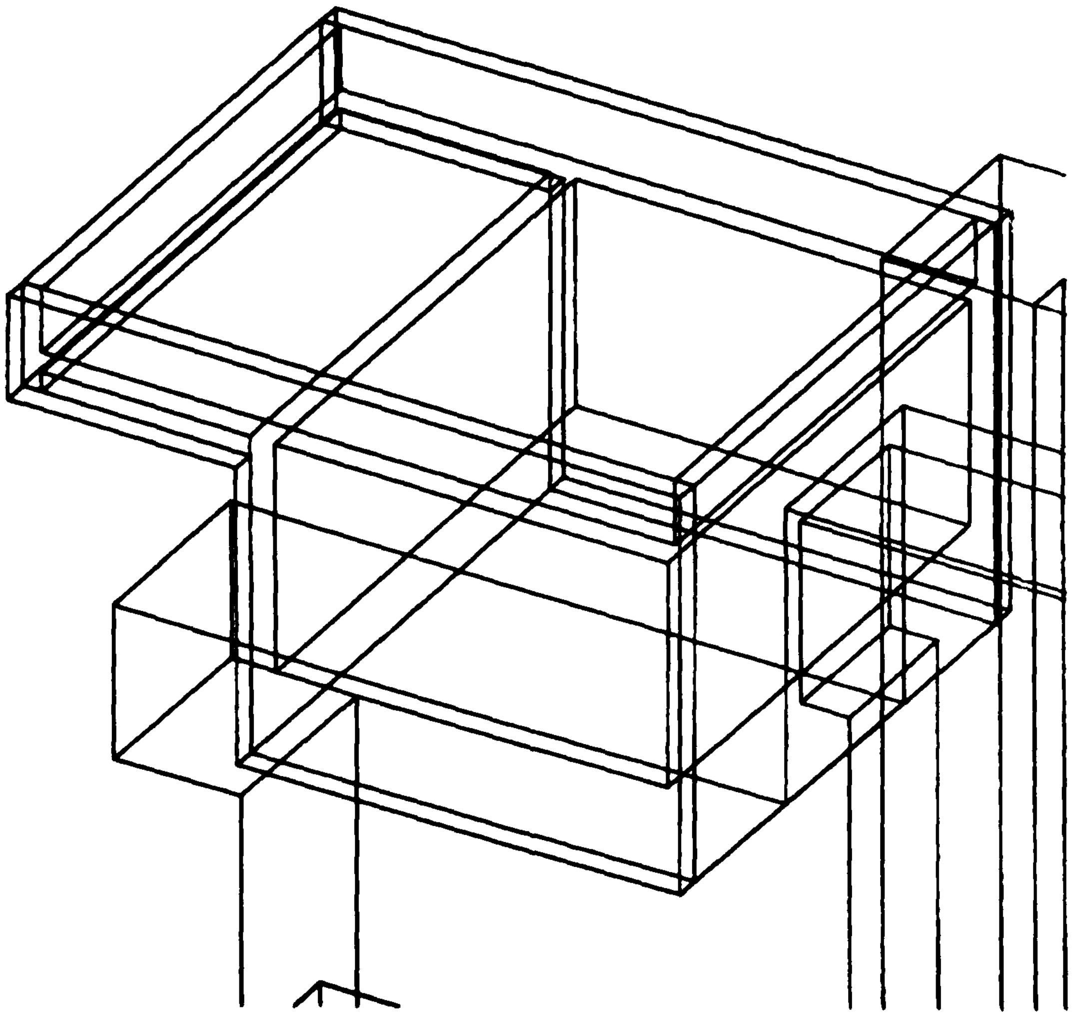
STRUCTURE 2
Front View

PLATE 2A



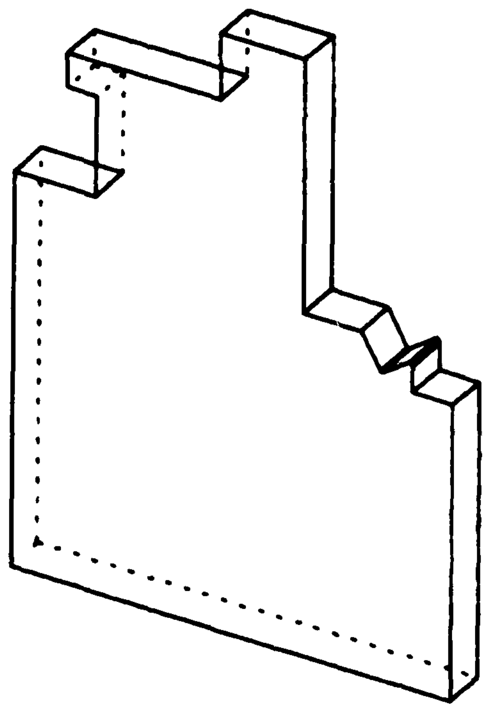
STRUCTURE 2
Overhead View

PLATE 2B



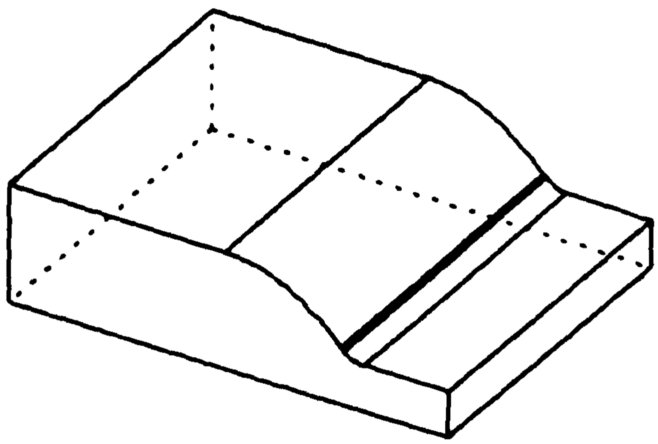
STRUCTURE 2
Window of
Overhead View

PLATE 2C



STRUCTURE 2
First Block

PLATE 2D



STRUCTURE 2
Second Block

PLATE 2E

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Tracy, Fred T
A three-dimensional stability analysis/design program (3DSAD); Report 1: General geometry module / by Fred T. Tracy. Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1980.
31 p., [5] leaves of plates : ill. ; 27 cm. (Instruction report - U. S. Army Engineer Waterways Experiment Station - K-80-4, Report 1)
Prepared for Office, Chief of Engineers, U. S. Army, Washington, D. C.
A report under the Computer-Aided Structural Engineering (CASE) Project.

1. Computer-aided design. 2. Computer-Aided Structural Engineering Project. 3. Computer programs. 4. Geometry. 5. Structural analysis. 6. Structural design. I. United States. Army. Corps of Engineers. II. Series: United States. Waterways Experiment Station, Vicksburg, Miss. Instruction report ; K-80-4, Report 1.
TA7.W34i no.K-80-4 Report 1

WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

	Title	Date
Technical Report K-78-1	List of Computer Programs for Computer-Aided Structural Engineering	Feb 1978
Instruction Report 0-79-2	User's Guide: Computer Program With Interactive Graphics for Analysis of Plane Frame Structures (CFRAME)	Mar 1979
Technical Report K-80-1	Survey of Bridge-Oriented Design Software	Jan 1980
Technical Report K-80-2	Evaluation of Computer Programs for the Design/Analysis of Highway and Railway Bridges	Jan 1980
Instruction Report K-80-1	User's Guide: Computer Program for Design/Review of Curvilinear Conduits/Culverts (CURCON)	Feb 1980
Instruction Report K-80-3	A Three-Dimensional Finite Element Data Edit Program	Mar 1980
Instruction Report K-80-4	A Three-Dimensional Stability Analysis/Design Program (3DSAD)	
	Report 1: General Geometry Module	Jun 1980